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(54) **DIRECT REDUCED IRON
MANUFACTURING SYSTEM**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

2,547,685 A 4/1951 Brassert et al.

4,439,233 A 3/1984 Faccone

(Continued)

FOREIGN PATENT DOCUMENTS

CA 1 224 337 A 7/1987

CA 2 719 602 A1 6/2011

(Continued)

OTHER PUBLICATIONS

Written Opinion dated Feb. 19, 2013, issued in corresponding
International Application No. PCT/JP2012/079766, with English
translation (10 pages).

(Continued)

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(57) **ABSTRACT**

A direct reduced iron manufacturing system includes a gas
reformer for supplying steam to reform natural gas, a gas
heater being a heating unit for heating a reformed gas
reformed by the gas reformer to a predetermined tempera-
ture, a direct reduction furnace for reducing iron ore directly
into reduced iron using a high-temperature reducing gas, an
acid gas removal unit having an acid gas component
absorber and a regenerator for releasing the acid gas, and a
recovery gas introduction line for supplying a recovery gas
released from the regenerator to each of a reforming furnace
of the gas reformer and a furnace of the gas heater.

8 Claims, 4 Drawing Sheets

